Inventory of Tiny Cryptanthe (*Cryptantha minima*) on CFB Suffield, Alberta September – October 2005

Cheryl Bradley and Reg Ernst

Edited by G. C. Trottier and R. Franken

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Inventory of Tiny Cryptanthe (*Cryptanthaminima*) on CFB Suffield, Alberta. September – October 2005

Cheryl Bradley[1] and Reg Ernst[2]

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SUMMARY

This report describes the methodology and results of a survey of known locations for tiny cryptanthe (*Cryptantha minima*) on CFB Suffield. There are five known subpopulations (element occurrences) of tiny cryptanthe (TC) on CFB Suffield with area of extent varying from <1 km^2 to 25 km^2. For all subpopulations there was a marked decrease in number of plants in 2005 compared to 2004. This large decrease suggests that conditions in 2005 were much less favourable to seed germination and plant growth than conditions in 2004. Qualitative comparison of the 2004 and 2005 habitat data suggests that TC plant numbers increase with higher amounts of bare soil within grasslands. Further inventory of TC will be most beneficial if done in years with conditions favourable to widespread seed germination and plant growth. Recommended future research should focus on the ecophysiology and habitat relationships of this annual species with emphasis on the seed bank, seed viability, and germination.

RÉSUMÉ

Le présent rapport décrit la méthodologie et les résultats d'un relevé des stations connues de la cryptanthe minuscule (*Cryptantha minima*) à la BFC de Suffield. Cinq sous-populations de cryptanthes minuscules sont répertoriées pour la BFC de Suffield. Elles s'étendent sur une superficie variant entre moins de 1 km^2 et 25 km^2. L'effectif de chacune des sous-populations était nettement inférieur en 2005 à ce qu'il était en 2004. Ce déclin donne à croire que les conditions étaient beaucoup moins favorables à la germination et à la croissance de l'espèce en 2005 qu'en 2004. Une comparaison des données recueillies en 2004 et en 2005 sur les caractères qualitatifs de l'habitat de la cryptanthe minuscule indique que l'effectif de l'espèce a tendance à augmenter lorsque la proportion de sol dénudé dans la prairie augmente. Il serait préférable d'effectuer les prochains relevés de la cryptanthe minuscule les années où les conditions seront très favorables à la germination et à la croissance de l'espèce. Il est recommandé de poursuivre les recherches sur l'écophysiologie et l'habitat de cette annuelle, en particulier sur le réservoir de graines et sur la viabilité des graines et leurs conditions de germination.

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1. Introduction

Tiny cryptanthe (*Cryptantha minima*) (TC) is an annual plant species listed as endangered under the *Species at Risk Act* in Canada. Its known distribution is along the South Saskatchewan River valley in Alberta and Saskatchewan extending from the confluence of the Oldman River and Bow Rivers to the confluence with the Red Deer River just east of the Alberta border.

Canadian Forces Base (CFB) Suffield has a significant portion of the known TC population in Canada. According to element occurrence records of the Alberta Natural Heritage Information Centre (ANHIC), TC was first reported on CFB Suffield in 1973 and again in 1994 and 2003 with just a few plants documented for each occurrence. In September and early October 2004, over 260,000 plants were counted in a systematic inventory, which included the southern portion of the Suffield National Wildlife Area (NWA) and the northwest corner of the Koomati training area. In July 2004, an isolated population of 399 plants was also found in the Middle Sand Hills portion of the NWA. This site was revisited on June 29, 2005 and only 22 plants were found.

In spring 2005, the Recovery Team for Plants at Risk in the Prairie Provinces (Recovery Team) articulated the need to evaluate the status of TC at known locations and to search other areas that were not adequately assessed for population counts and habitat description. During field visits in early August 2005 to two known locations for TC outside of CFB Suffield (Medicine Hat and Purple Springs Dunes), few or no TC plants were found at locations where there had been many in 2004 (C. Bradley, pers. obs.). Based on these findings, provincial agencies decided to forgo a 2005 survey for TC. However, the Canadian Wildlife Service (CWS), with the support of the Department of National Defence, Canadian Forces Base Suffield (the Base), proceeded with a contract for a professional botanist to undertake a survey of known locations for TC on CFB Suffield. This report describes the methodology and results of that survey.

2. Objectives

Specific objectives of this project are:

- To inventory TC on CFB Suffield in 2005 and describe the habitat where TC is located. Search focus will be on areas where the species was previously found and in the Koomati training area but may expand beyond that if time permits.
- To provide a qualitative assessment of ecological factors affecting TC distribution and population size.

3. Methods

Our understanding of TC populations in Canada is still at the inventory stage. Methods used for inventory are designed to locate populations of a species, describe the habitat, and assess threats (Elzinga et al. 1998). These methods may not be appropriate for re-measurement and long-term monitoring that must be done in the context of management objectives.

3.1. Reviewing Background Information

We reviewed key sources of information on TC occurrences on CFB Suffield and elsewhere. These included a status report of TC in Alberta (ASRD 2004) containing information on occurrences up to and including August 2004, and we reviewed a report containing the results of a survey conducted in September 2004 outside of CFB Suffield (Bradley and Ernst 2004). We also reviewed a report of a survey for slender mouse-ear-cress (*Halimolobos virgata*) (Elchuk 2005) that contained information on TC found in June 2005 in the sand hills of the Ypres training area. As well, we obtained information on TC found in July 2005 near a compressor station in Koomati (M. Decker, pers. comm.).

A report on a survey for TC during September and early October 2004 was not available at the time of writing this report and hence survey method is briefly described here. The 2004 field work was a preliminary inventory conducted mainly in the southern portion of the National Wildlife Area focused on areas with sandy soils (Fish Creek and Casa Berardi south, Casa Berardi north and Mons). Fourteen search areas were defined totaling about 60 km^2 and involving about 169 hours of concentrated searching. Initially, the search was conducted using a quad to run parallel transects about 10 metres apart and occasionally also in a perpendicular direction (D. Nernberg, pers. comm.). Once it was apparent where plants were most likely to occur in a search area, the search focused on those sites. When TC plants were encountered, GPS coordinates were recorded and counts or estimates of number of plants and area occupied were made. Site characteristics were briefly described. The western portion of the Koomati training area was also searched but only briefly during a few hours near sundown in early October. As well, one site was found accidentally in Ypres in mid-July and was documented during a return visit involving more intensive search along 1 km of trail for about 6 hours (B. Smith pers. comm., D. Nernberg pers. comm.). In the 2004 survey, the total search area was about 65 km^2 and total search time was approximately 178 hours (D. Nernberg pers. comm.).

Data from previous reports of TC on CFB Suffield were contained in two Excel files provided by CWS and the Base:

- Suffield Sept 2004.xls. The file contains information on location (UTM coordinates), population size (number of plants and areal extent), site (slope, aspect) and vegetation (dominant species, associated species, % bare ground).
- TC_Suffield_Location_FinalAug'05.xls. This file contains information on location (site name, region (training area, UTM coordinates), population size (number of plants and areal extent) and the map unit which applies to each TC location for a variety of ecological GIS layers (e.g. soil landscape model, landform, soil texture and site characteristics, ecological land class and vegetation cover type).

Search areas for the 2004 survey in CFB Suffield and the 688 GPS locations/sites where TC was found in 2004 are mapped in Figure 1. Records of TC in CFB Suffield prior to the 2005 survey are summarized in Table 1 and Figure 1.

Tiny_cryptanthe_search_areas_2005_with_attributes.shp – Digitized and provided by DND.

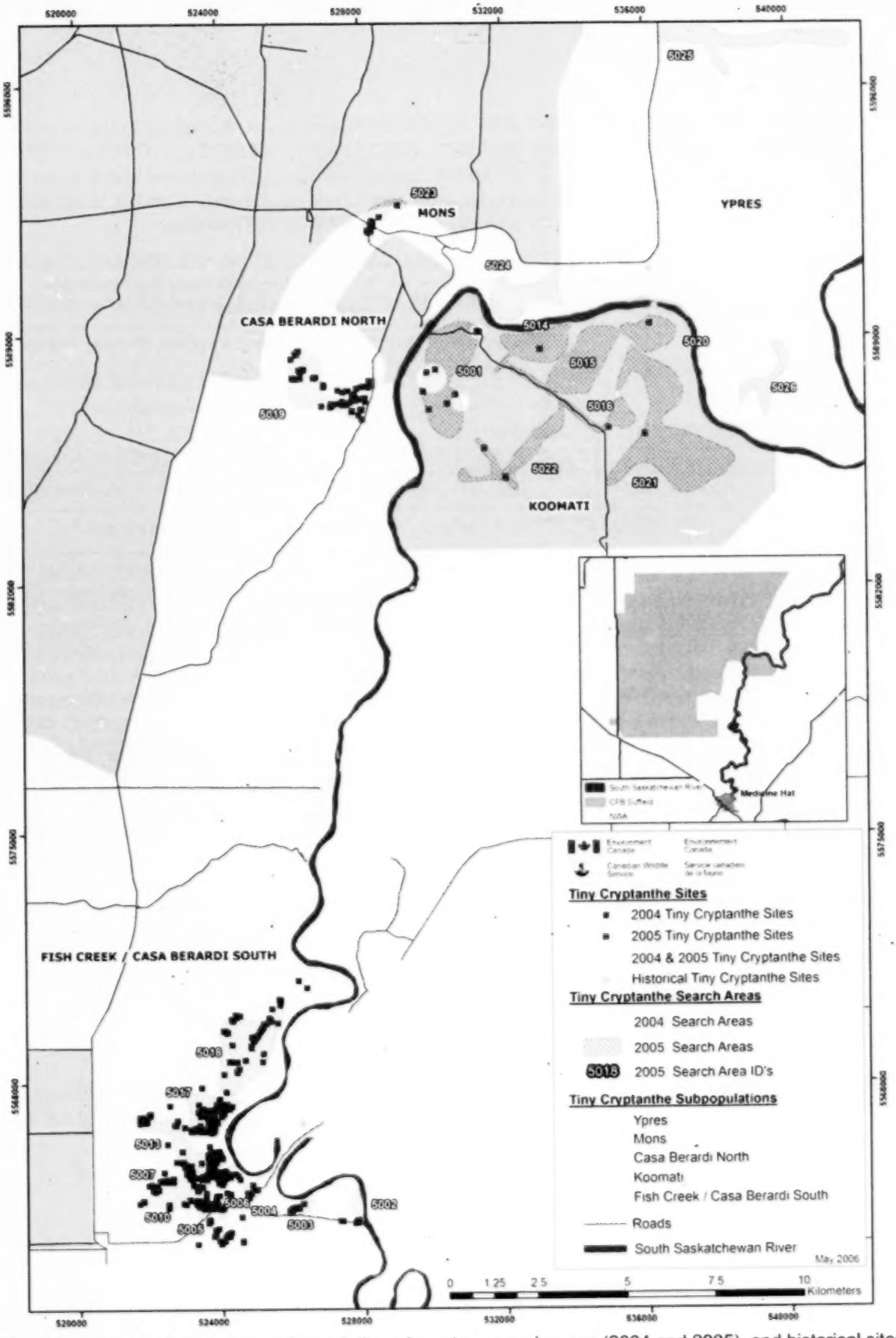

Figure 1. Tiny cryptanthe sites, subpopulations, inventory search areas (2004 and 2005), and historical sites at CFB Suffield, Alberta. (Prepared by G. Turney, Canadian Wildlife Service, Edmonton, AB.)

Table 1: Records of TC on CFB Suffield prior to 2005 survey

Year	Training Area UTM NAD 83 12 U	Surveyor	Results
1973 Jul 22	Fish Creek 526241E 5566872N	Hope Johnson	2 plants in Bull Pen area
1994 Jul 7	Ypres 536150E 5590850N	Ian Macdonald	1 plant along Mule Deer Road in Mule Deer Spring valley
2003 Jul 22	Koomati 530121E 5588039N	Ian Macdonald Garry Trottier	1 plant on terrace at base of slope in NW Koomati
2004 Jul 14	Ypres 539090E 5595925N	Dean Nernberg Brent Smith	399 plants along trail through dunes in central Ypres
2004 Sep-Oct	Casa Berardi, Fish Creek, Koomati, Mons (for UTMs see Suffield Sept 2004.xls)	Dean Nernberg	262,050 plants in four subpopulations (Fish Creek/Casa Berardi South, Casa Berardi North, Mons, Koomati)
2005 Jun 29	Ypres 539066N 5595875E 539131E 5595824N	Candace Elchuk, Dean Nernberg, Jennifer Neudorf	22 plants in 2 clumps along trail across stabilized dune in central Ypres; same site as 2004 record
2005 Jul 27	Koomati 530173E 5588621N	Mari Decker	7 plants along trail to a compressor station in NW Koomati

Results of inventory in 2004 led to definition of five TC subpopulations in CFB Suffield, which are named according to the training areas where they are found - Koomati, Fish Creek/Casa Berardi South, Casa Berardi North, Mons, and Ypres. There may be a sixth subpopulation near Mule Deer Springs in the southern portion of Ypres, but only one plant was found there in 1994; the 2004 search effort did not cover that area.

Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little exchange, typically one successful migrant individual or gamete per year or less (IUCN 2001). In the absence of genetic information, the Alberta Natural Heritage Information Centre (ANHIC) considers groups of plants separated by roughly 1 km or an obvious ecological barrier (e.g. a river) as separate element occurrences (J. Gould, pers. comm.). We use the term subpopulation when referring to element occurrences for the purposes of this report.

We used inventory results from 2004 to define extent of occurrence for each subpopulation on CFB Suffield. Extent of occurrence is defined as a polygon containing all known locations for a species (IUCN 2001).

3.2. Defining Search Approach

Based on a review of data from previous search effort, and given the limitations on resources available for the project, we took the following approach to the 2005 search to inventory known populations. We ensured that, at a minimum, the boundaries and centre of extent of occurrence

of known subpopulations were sampled, as well as those sites with the most plants within the subpopulation. Table 2 shows for each subpopulation the pre-2005 sites which were targeted for visits. Since very few TC plants were encountered, we visited more pre-2005 sites than identified in Table 2, and we searched areas between target sites.

Table 2: Sites within known subpopulations targeted for visits in 2005

Subpopulation/Element Occurrence	**Pre-2005 Sites Targeted for Visits in 2005**[a]
Koomati	1, 627, 629
Fish Creek/Casa Berardi South	3, 9, 631, 671, 225, 222&223, 198, 491, 492, 687, 165, 413, 511&519, 375, 50&56, 523, 526, 536, 97, 89, 110, 127, 130, 152, 16, 146, 12
Casa Berardi North	611, 623, 581, 584, 619, 570, 574, 566, 559
Mons	542, 688, 689, 690

[a] Site numbers (FID_TC) are found in TC_Suffield_Location_FinalAug'05.xls

At the request of CWS and the Base, we focused search effort for new locations of TC on the Koomati training area. Some search effort for new locations also was directed to an area just east of Sherwood Forest, Murphy's Horn, and the Middle Sand Hills - all within the Ypres training area. Criteria for selecting new locations to inventory were defined based on qualitative assessment of habitat information for TC from previous surveys (ASRD 2004, Bradley and Ernst 2004, C. Elchuk pers. obs., D. Nernberg pers. obs.) and the results of overlaying various GIS layers on TC distribution in CFB Suffield. We defined habitat suitability criteria as follows:

- Distance from river: Areas within 5 km.
- Landform: Glaciofluvial terrace, river valley slope, coulee/ravine slope and bottom, shallow basin, sandy plain and sand dunes.
- AGRASID Landscape Model: ATP, BUT, BVCV, CVD, CVPL, EXP and ZUN. These map units are characterized by fluvial or eolian parent material of medium to coarse texture. Soils are orthic brown chernozems, rego chernozems and orthic regosols (Landwise Inc. 2003).
- Soil texture: Sandy loam, loamy sand, silty sand and sand. One pre-2005 TC site in South Nishomoto flats is described as 'limy'.
- Aspect: usually south or east, infrequently north and west
- Slope: 0-50% (0-25°(35°))
- Moisture regime: xeric, well-drained
- Vegetation: Dry mixed grassland dominated by needle-and-thread (*Stipa comata*) and blue grama (*Bouteloua gracilis*). Plant species commonly associated with tiny cryptanthe are prickly pear cactus (*Opuntia polycantha*), Pursh's plantain (*Plantago patagonica*), low sedge (*Carex stenophylla*), Indian rice grass (*Oryzopsis hymenoides*), pasture sage (*Artemesia frigida*), bluebur (*Lappula squarrosa*), Russian thistle (*Salsola kali*), and goosefoot (*Chenopodium praticola*).
- Bare soil: low soil litter levels and a minimum of 10% bare soil, usually more.

3.3. Permitting

Prior to entry to the base, CWS submitted a CFB Suffield NWA Application for Access Permit and an Activity Description. We received Permit 2005-SCI-009. We also attended a safety

briefing through Range Control to obtain a Range Safety Permit before entry onto the range. As well, CWS made application for a permit to collect tiny cryptanthe plants under section 73(1) of the *Species at Risk Act* (Permit 2005-03AB).

3.4. Inventory of Search Areas

The search was undertaken over eight full field days in September and early October. In Alberta, TC is known to flower in summer with fruits maturing in late summer to early fall (ASRD 2004). Mature fruits are needed for positive identification. Plants remain stiff, erect, and identifiable well into the fall.

A search area is defined as a polygon encompassing all the points visited while searching for TC during a discrete, uninterrupted period of time. Unique identification numbers were assigned sequentially, beginning at 5001, in the order in which searches were done. Twenty-three search areas were defined during the survey, varying greatly in size (Figure 1). Search area 5007 combined three small, contiguous search areas: 5007, 5008, and 5009. Search area 5013 combined 5011, 5012, and 5013.

Searches were conducted while walking and also from a vehicle while driving slowly along trails and periodically stopping to do a short transect perpendicular to the trail. All parts of a polygon did not receive the same level of search intensity, as the survey targeted sites where tiny cryptanthe was known to occur or where tiny cryptanthe was considered most likely to occur (e.g. patches of bare soil), as opposed to systematic sampling. In areas where TC had previously been found, a Garmin satellite-based GPS navigator was used to locate the pre-2005 site UTM coordinates (NAD 83). From the GPS point, a circle at least 50 metres in radius was thoroughly searched. Between target sites, the search pattern was a meandering traverse.

Search areas were mapped on air photo composites with a UTM grid overlay (1:10,000 for Koomati and 1:30,000 for southern portion of NWA). Where composites were not available, areas were mapped on individual air photos (1:20,000) or, in one case, a 1:50,000 map.

For each search area, the following information was recorded: region, date, observer, map reference, landform parent material, landform modifier, search area size, search method, search time, land use, notes about disturbance (natural or human), and whether TC was found, of the current or previous year. These terms are defined in Appendix 1.

3.5. Recording Tiny Cryptanthe Sites

When TC plants of the current year were found within a search area, a unique site number was assigned (sequentially beginning at 700). From the point where the plant was first located, progressively larger search circles were walked to determine the area occupied by TC plants. The following information was recorded for each site: search area, date, observer, population size, area of occupancy, distribution, phenology code, UTM coordinates, topographic position, aspect, slope, soil range site and texture, moisture regime, soil drainage, plant community, % woody cover, % bare ground, and associated plant species. Notes were also made regarding disturbance (human or natural). These terms are defined in Appendix 1.

Occasionally, a photo or plant collection was taken, especially if there was some uncertainty about identification. TC may be confused with Kelsey's cryptanthe (*Cryptantha kelseyana*) also

found in CFB Suffield. Specimens were keyed using a dissecting scope. Because plants were brown and brittle, very few were suitable herbarium specimens. One specimen of TC (RE 05-004) has been mounted and labeled and provided to CWS.

Other plants on the Vascular Plant Species Tracking List of the Alberta Natural Heritage Information Centre (Vujnovic and Gould 2002) were also recorded using similar methods. Completed report forms for Kelsey's cryptanthe and false buffalo grass (*Munroa squarrosa*) were prepared for the Alberta Natural Heritage Information Centre.

3.6. Compiling and Analysing Data

Information from field forms is contained in Excel file: 2005 TC Survey CFB Suffield.xls. Terms used as column headings for the Excel file are defined in Word file: 2005 TC Survey Metadata.doc and provided in Appendix 1. These files are deposited with CWS and the Base. Search area polygons, mapped on air photos and air photo composites (orthorectified), were digitized and are part of the GIS database for CFB Suffield. Results of the surveys were provided to the Alberta Natural Heritage Information Centre (ANHIC) for inclusion in their standardized database of information on biodiversity in the province.

We undertook qualitative assessment of search effort, TC occurrences, and ecological factors affecting TC distribution and population size.

4. Results and Discussion

4.1. Search Effort in 2005 and Comparison with 2004 Survey

In 2005, search effort for TC on CFB Suffield covered a total area of 33 km^2 and involved 68 hours of concentrated searching. About 50% (16 km^2) of area searched and 59% (40 hrs) of the time dedicated to searching occurred in the extent of occurrence of individual TC subpopulations defined from the 2004 survey. The remainder of search effort was in areas within the Koomati and Ypres training areas that appeared to meet criteria for suitable habitat and was not searched in 2004.

The 2004 search effort was the first systematic inventory for TC conducted on CFB Suffield and was much more extensive in area than the 2005 search effort. Search effort for TC in 2004 covered a total area of 65 km^2 over 178 hours. Because TC was found in many locations (688 GPS points) and often in great abundance in 2004, search effort required considerably more time to count number of plants compared to 2005. The 2004 inventory provided important information for defining the number, location, and area extent of subpopulations in the southern portion of the NWA. The 2005 TC survey focused within the known extent of occurrence of each of five subpopulations and expanded the inventory effort in Koomati and portions of Ypres.

Additional search effort for species at risk, including TC, occurred in 2005 by other researchers on CFB Suffield. CWS staff spent 103.5 hours of search effort in the Middle Sand Hills, Amiens, and Ypres training areas focused on slender mouse-ear-cress (Elchuk 2005). TC was found at one site, the same one reported for Ypres in 2004. From July to September, TERA Environmental Consultants (TERA) conducted approximately 420 hours of search effort in areas west of the South Saskatchewan River proposed for gas field development (M Decker pers.

comm.) and a brief visit to a new compressor station in Koomati training area. They found TC at one site in Koomati.

4.2. Subpopulations in 2005 and Comparison with 2004 Survey

Twenty-seven sites for TC were recorded in the 2005 survey (Table 3, Figure 1). Twenty of the 2005 sites are within the extent of occurrence of three subpopulations defined in 2004 – Fish Creek/Casa Berardi South, Casa Berardi North and Koomati (Figure 1). Seven sites were in a portion of the Koomati training area that was not searched in 2004. No TC plants were found in 2005 in the Mons training area within the area of occupancy for the subpopulation defined in 2004. In addition, there was one site recorded by CWS surveyors in the Ypres training area at the same location as the 2004 record (Elchuck 2005). There was one other site recorded in northwest Koomati during a plant survey by TERA (M. Decker, pers. comm.).

In 2005, there was a large overall decrease in TC sites and number of plants counted in all five subpopulations compared to 2004 (Table 4). There were 688 GPS points recorded in 2004. This does not necessarily mean there was a large decrease in the population, since a portion of the population is buried as viable seed and was not inventoried. Conditions in 2004 appeared to have been favourable for abundant TC germination and establishment, whereas, conditions in 2005 were less favourable. Large fluctuation in plant numbers from year to year is not uncommon in annual plant species (Elzinga et al. 1998).

The results of the 2005 inventory do not change the determination that there were five subpopulations or occurrences of TC in CFB Suffield, with a possibility of a sixth unconfirmed site near Mule Deer Springs. Although we did not find any plants in the Mons subpopulation in 2005, it is hypothesized that the subpopulation is present in the soil seed bank. Several years of monitoring and failure to find plants would be required to consider a subpopulation extinct.

TC sites found in the Koomati training area in 2005 were, in some cases, separated by more than 1 km and hence five separate subpopulations or occurrences could be defined (Figure 1). This would increase the number of subpopulations to nine. Habitat between the Koomati TC sites, however, appears to meet suitability criteria for TC. It is hypothesized that TC plants would be found in the intervening areas during a year with conditions favouring seed germination and plant growth and hence genetic exchange would occur. The extent of occurrence of the Koomati subpopulation, therefore, was expanded from 2 km^2 to 25 km^2 until such time as evidence indicates otherwise. More monitoring is required to ascertain with an acceptable level of confidence the extent of occurrence of the Koomati subpopulation.

Table 3: Tiny cryptanthe sites reported in 2005.

Subpopulation, Site #	Number of plants and areal extent	Site Description
Fish Creek/Casa Berardi South		
Site 704	1 plant	Upland plain; level; 80 % bare soil; fenceline, no obvious disturbance
Site 705	15 plants in 50 m^2	Terrace; SE aspect; 50% bare soil; beside truck trail
Site 706	12 plants in 1 m^2	Toe of slope; SE aspect; 45% bare soil; road ditch
Site 707	5 plants in 1 m^2	Upland plain; level; 40% bare soil; beside truck trail
Site 708	10 plants in 60 m^2	Mid slope; S aspect; 55% bare soil; pocket gopher diggings
Site 709	75 plants in 30 m^2	Mid slope; S aspect; 30% bare soil; cleared area
Site 710	85 plants in 224 m^2	Upper slope; SE aspect; 45% bare soil; pipeline ROW
Site 711	8 plants in 9 m^2	Ridge crest; SE aspect; 45% bare soil; fenceline, no obvious disturbance
Site 712	6 plants in 2 m^2	Upland plain; level; 10% bare soil; fenceline, no obvious disturbance
Site 713	9 plants in 150 m^2	Upland depression; level; 90% bare soil; pocket gopher diggings
Site 714	69 plants in 200 m^2	Mid slope; E aspect; 20% bare soil; no obvious disturbance
Site 715	5 plants in 9 m^2	Upland plain; level; 80% bare soil; fence near building
Site 718	60 plants in 175 m^2	Toe of slope; E aspect; 35% bare soil; near gas well site
Casa Berardi North		
Site 719	15 plants in 30 m^2	Mid slope; SE aspect; 35% bare soil; road side
Site 720	5 plants in 2 m^2	Toe of slope; S aspect; 30% bare soil; no obvious disturbance
Site 721	50 plants in 300 m^2	Lower slope; SE aspect; 35% bare soil; no obvious disturbance
Koomati		
Site 700	200 plants in 100 m^2	Upper slope; N& SE aspect; 30-50% bare soil; pipeline ROW
Site 701	5 plants in <1 m^2	Bench; level; 25% bare soil; pipeline ROW
Site 702	75 plants in 1500 m^2	Dip slope; SE aspect; 50-70% bare soil; pipeline ROW
Site 703	1 plant	Mid slope; W aspect; 50% bare soil; pipeline ROW
Site 716	6 plants in 150 m^2	Upland plain; S aspect; 55% bare soil; gas well site
Site 717	50 plants in 75 m^2	Upper slope; SE aspect; 50%; pipeline ROW
Site 722	6 plants in 40 m^2	Terrace; NE aspect; 55% bare soil; pipeline ROW
Site 723	5 plants in 30 m^2	Upland depression; E aspect; near well site
Site 724	90 plants in 1000 m^2	Mid slope to toe; SE aspect; 55% bare soil; pipeline ROW
Site 725	1 plant	Lower slope; S aspect; 50% bare soil; pipeline ROW
Site 726	20 plants in 300 m^2	Lower slope; S aspect; no obvious disturbance

Table 4: Comparison between plant counts and distribution of TC in 2004 and 2005

Subpopulation	2004 Search: # TC plants (# GPS points in extent of occurrence)[a]	2005 Search: # TC plants (# sites in search area)	Change in # plants
Fish Creek/Casa Berardi South	172,174 (595 in 24 km^2)	360 (13 in 7.5 km^2)	large decrease
Casa Berardi North	72,475 (71 in 3 km^2)	70 (3 in 2.0 km^2)	large decrease
Mons	16,011 (15 in 1 km^2)	0 (0 in 0.5 km^2)	large decrease
Ypres	399 (1 in <1 km^2)	22[b] (1 in 7.0 km^2)	decrease
Koomati	1390 (6 in 2 km^2)	466[c] (12 in 16.0 km^2)	decrease

[a]area of a minimum size polygon containing all GPS points with TC in 2004
[b]record of 22 plants reported in Elchuk (2005)
[c]includes record of 7 plants during TERA survey (M. Decker, pers. comm.)

4.3. Habitat Factors

In 2005, TC was found on upland plains, upland depressions, ridge crests, upper slopes, mid slopes, dip slopes, toe of slopes, and terraces. Eighteen of the 27 sites had a south, southeast or east aspect, six sites were level, and only one site each had a north, northeast, or west aspect. Slopes varied from 0 to 30 percent, with 21 of the 27 sites having a slope less than 10% (6°). Surface soil particles were predominantly sand and coarse in texture. Twelve of the 27 sites were considered to have enough finer particles to be classified as a sandy loam of medium texture. All sites were dry and well-drained.

Nineteen of the 27 sites occurred in grasslands where needle-and-thread (*Stipa comata*) and blue grama (*Bouteloua gracilis*) each had more than 15% cover (*Stipa comata-Bouteloua gracilis* Community Type) (Adams et al. 1997). Eight sites were in grasslands with needle-and-thread cover less than 15% and blue grama more abundant (*Bouteloua gracilis-Stipa comata CT*). Plant species found on five or more of the 27 TC sites were Russian thistle (*Salsola kali*), Fendler's cryptanthe (*Cryptantha fendleri*), pasture sage (*Artemesia frigida*), prickly pear cactus (*Opuntia polycantha*) and Indian rice grass (*Oryzopsis hymenoides*). Woody shrub cover, such as sagebrush (*Artemisa cana*) and prairie rose (*Rosa woodsii*), was less than 10%, and generally 0%, at all sites.

Bare ground occupied more than 20%, and was as high as 90%, on all but two sites. Eighteen of the 27 sites were associated with human disturbance, including pipeline right-of-ways and vehicle trails. Two sites had recent pocket gopher mounds. Seven sites were not associated with any obvious disturbance that would have resulted in bare ground. Drought and hoof action of grazing animals are possible contributors to high bare ground cover.

TC was not relocated at some sites where it was previously located in 2004, possibly due to higher vegetation cover and lower amount of bare ground (< 20%) in 2005. It is hypothesized

that tiny cryptanthe seeds do not germinate in areas shaded by plant leaves and stems or with accumulation of dead plant material (litter). Factors that contribute to germination and establishment of TC, however, have not been investigated.

5. Conclusions and Recommendations

There are five known subpopulations (element occurrences) of TC on CFB Suffield with an area of extent varying from <1 km^2 to 25 km^2. The five subpopulations are 1) Fish Creek/Casa Berardi South (24 km^2), 2) Casa Berardi North (3 km^2), 3) Mons (1 km^2), 4) Ypres (<1 km^2) and, 5) Koomati (25 km^2). Additional surveys are needed to confirm that the Fish Creek/Casa Berardi South subpopulation and the Koomati subpopulation are each accurately represented as one subpopulation rather than several, more localized subpopulations that are genetically isolated. A possible sixth subpopulation may exist in the southern part of Ypres based on a record of one plant in the Mule Deer Springs valley in 1994, however, this should be confirmed.

TC plant counts varied greatly between 2004 and 2005. For all subpopulations, there was a marked decrease in number of plants in 2005 compared to 2004. This large decrease suggests that conditions in 2005 were much less favourable to seed germination and plant growth than conditions in 2004. It does not necessarily mean a decline in population since a significant portion of the population may be buried viable seed that was not inventoried. This poses significant challenges for population viability analysis, including detecting declines leading to extinction (Elderd et al. 2003). However, monitoring presence or absence of mature individuals and counting or estimating the number of mature individuals and their extent will determine germination and establishment in a given year, help to assess factors which promote germination, and if conducted over several years, assist in evaluating the status of subpopulations over time and inform conservation efforts (Elzinga et al. 1998, ASRD 2004).

TC is distributed along the South Saskatchewan River valley in southeastern Alberta and southwestern Saskatchewan which has the region's highest annual moisture index (eg., Figure 45, Barrow and Yu 2005). Annual moisture index is defined as the ratio of the annual degree day total (using a threshold temperature of 5°C) to annual total precipitation. It combines temperature and precipitation information into an index that can indicate moisture availability for plant growth. Increases in the index indicate either increases in the degree-day total or decreases in annual precipitation. This is consistent with the hypothesis that TC thrives during drought periods, when most other plants do not. TC may have colonized southern Alberta and Saskatchewan during an historical prolonged hot, dry period and the species continues to persist in the hottest and driest areas. Annual moisture index in the Canadian portion of TC's range is predicted to increase under climate change, which may cause TC populations to increase and expand.

Additional research is needed to ascertain the factors contributing to seed viability, seed germination, and plant growth. Qualitative comparison of the 2004 and 2005 habitat data suggests that TC plant numbers increase with higher amounts of bare soil within grasslands. Drought periods, which suppress grass growth and lead to decrease in litter, may produce conditions that allow TC seeds in the soil to receive the amount of sunlight they need to germinate and the relative freedom from competition they need to grow. Under such conditions, TC appears to be widespread throughout its habitat. During wetter periods when grassland productivity is high and there is abundant litter TC plants appear mostly on patches of bare soil produced by animals (pocket gopher mounds, hoof action of ungulates, animal trails) and humans (pipeline right of ways, truck trails). TC is not usually found on areas with frequent and

repeated disturbances that compact soil (roads, oil and gas facilities, cultivation). As well, previous work has shown that TC does not occur on sites converted to crested wheat grass, perhaps due to an allelopathic effect (ASRD 2004).

Some possible areas requiring further investigation include: determining how long the seed of TC remains viable, whether patch disturbances during less favourable periods are critical for survival of a population, and the effect of fire and livestock use on seed viability and their role in maintaining suitable TC habitat. As well, because TC can be confused with Kelsey's cryptanthe even by experienced botanists, more work is needed to understand the characteristics that differentiate TC and Kelsey's cryptanthe in the Canadian portion of their ranges. During the 2004 and 2005 survey, the two at-risk species were occasionally found growing together, and some specimens appeared to integrade between the two species.

Further inventory of TC would be most beneficial if done in years with conditions favourable to widespread seed germination and plant growth. As well, surveyors should be provided documentation of all prior rare plant survey in CFB Suffield including year and time of search, areas searched, methodology, and results.

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APPENDIX 1 - Definition of terms for excel file *2005 Survey CFB Suffield.xls*

The following is a definition of column headings for the excel file 2005 TC Survey CFB Suffield.xls. There are two sheets in the file. Sheet 1 describes areas searched for tiny cryptanthe and sheet 2 describes sites where tiny cryptanthe was found.

Sheet 1 – 2005 Search Areas

Search Area (SA)
A search area is a polygon encompassing all the points visited while searching for tiny cryptanthe during a discrete, uninterrupted period of time. Unique identification numbers were assigned sequentially, beginning at 5001, in the order in which searches were done. Searches were conducted on foot and also from a vehicle while driving slowly along trails. All parts of a polygon did not receive the same level of search intensity since the survey technique was not in a systematic pattern but rather targeted on sites where tiny cryptanthe was known to previously occur or where tiny cryptanthe was considered to most likely occur. Between targeted sites the search pattern was a meandering traverse. The polygon is drawn to include all the targeted sites and the path of the meandering traverse.

Region
The region name corresponds to the name of the training area(s) in CFB Suffield in which the search area is located (e.g. Fish Creek, Casa Berardi, Koomati, Mons, Ypres). For some search areas another name is added which helps to locate the search area within the training area.

Date
The date on which the search was conducted.

Observer
The name of the person(s) conducting the search.

Map Reference
This identifies the map base on which the observers delineated the search area during or shortly after the search. Most search areas are delineated on two air photo composites – 1) National Wildlife Area (1:30,000) with a UTM grid overlay and 2) Koomati (1:10,000) without UTM grid overlay. Where air photo composite coverage was not available search areas were delineated on 1993 air photos (1:20,000). One search area (5023) was delineated on the CFB Suffield East topographic map (1:50,000).

Landform Parent Material
This is the predominant mineral material underlying the search area from which the landforms are derived (e.g. glaciofluvial, morainal, eolian) as defined in Agriculture Canada Soil Classification Working Group (1998). Determination of parent material was made by reference to the Soil Map for Medicine Hat 72L/SE (1:126,720) (Land Resource Research Centre Contribution No 90-26) and a refinement of this on maps (1:30,000) provided by the Canadian Wildlife Service.

Landform Modifier
This is the form and pattern or surface expression of the parent materials (e.g. inclined, level, undulating, terraced) as defined in the Canadian System of Soil Classification 3rd Edition (1998).

Hummocky – A very complex sequence of slopes extending from somewhat rounded depressions to irregular knolls with slopes of 9-70% (5-35°).
Inclined – A sloping, unidirectional surface with a generally constant slope of 2-70% (1-35°) not broken by marked irregularities.
Level – a flat or very gently sloping, unidirectional surface with a generally constant slope of <2% (1°) not broken by marked irregularities.
Ridged – A long, narrow elevation of the surface, usually sharp crested with steep sides.
Terraced – A scarp face and the horizontal or gently inclined surface (tread) above it.
Undulating – A regular sequence of gently slopes that extends from rounded, sometimes confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3°).

Search Area Size
The surface area in hectares of the search area is provided based on estimates from map measurement. For some search areas more detail on shape and dimensions also is provided.

Search Method
The method used in the search is described. If the search targeted previously known locations for tiny cryptanthe, this is noted and the site identification numbers are cited which were assigned by Canadian Wildlife Service in an excel file which they created (see FID_TC column in TC_Suffield_Location_FinalAug'05.xls). Information is provided on whether the search was done on foot and/or by vehicle, pattern of the search (meandering, along trail, regularly spaced transects) and portions of the search area or features within it that received particular focus (e.g. bare soil patches, well sites, disturbances).

Search Time
An estimate of the time spent searching in each search area is provided.

TC of 2005
'No' means tiny cryptanthe of the current year was not found in the search area. 'Yes' means tiny cryptanthe plants from the current year were found and the site number(s) assigned to the occurrence(s) is provided in brackets. 2005 site numbers begin at 700. Occurrence reports are found in the database of the Alberta Natural Heritage Information Centre, Edmonton.

TC of Previous Year
'Yes' means dried-up remnants of plants from a previous year (dried stems, fruits) were found whereas 'No' means they were not.

Notes
This column contains observations
about where tiny cryptanthe plants occur within the search area and subjective assessments about why no plants were found in previously known locations.

Land Use
This column contains general observations on anthropogenic land uses within the search area.

Sheet 2 – 2005 TC Sites

Site #
Site # is a unique identifier of each location where tiny cryptanthe was found during the search. Site numbers were assigned sequentially beginning at 700.

Previous Site #
These are site numbers of previous tiny cryptanthe locations that the observer was targeting when the 2005 occurrence was found nearby (i.e. within a hundred metres of the previous site based on UTM coordinates). This is not necessarily the closest occurrence that had been previously reported. Information on previous occurrences is in an excel file created by Canadian Wildlife Service named TC_Suffield_Location_FinalAug'05.xls

Region
The region name corresponds to the name of the training area(s) in CFB Suffield in which the search area is located (e.g. Fish Creek, Casa Berardi, Koomati, Mons, Ypres). For some search areas another name is added which helps to locate the search area within the training area.

Search Area (SA)
This is the corresponding search area number for the occurrence. A search area is a polygon encompassing all the points visited while searching for tiny cryptanthe during a discrete, uninterrupted period of time. Unique identification numbers were assigned sequentially, beginning at 5001, in the order in which searches were done.

Date
The date on which the search was conducted and the occurrence recorded.

Observer
The name of the person(s) conducting the search.

Photo/Collection
If a photo was taken or a collection made it is identified in this column.

Population Size
The number of tiny cryptanthe plants counted at the site.

Area of Occupancy
The approximate area in square metres of a rectangle that would encompass all tiny cryptanthe plants found at the site.

Distribution
The spacing of plants within the area of occupancy – clumped or scattered.

Phenology Codes
Codes representing the vegetative (V) and Reproductive (R) states of tiny cryptanthe plants. The categories are taken from the *Rare Native Plant Report Form* of the Alberta Natural Heritage Information Centre. The form is available at www.cd.gov.ab.ca/preserving/parks/anhic/plant_trk_wtch.asp.

Phenology Codes for Herbs (after Dierschke, 1972)

VEGETATIVE (V)

0 Without shoots above ground
1 Shoots without unfolded leaves
2 First leaf unfolds
3 2 or 3 leaves unfolded
4 Several leaves unfolded
5 Almost all leaves unfolded
6 Plant fully developed
7 Stem and/or first leaves fading
8 Yellowing up to 50%
9 Yellowing over 50%
10 Dead

REPRODUCTIVE (R)

0 Without blossom buds
1 Blossom buds recognizable
2 Blossom buds strongly swollen
3 Shortly before flowering
4 Beginning bloom
5 Up to 25% in blossom
6 Up to 50% in blossom
7 Full bloom
8 Fading
9 Completely faded
10 Bearing green fruit
11 Bearing ripe fruit
12 Bearing overripe fruit
13 Fruit or seed dispersal

UTM1, Easting and Northing
Universal Transverse Mercator grid coordinates of the location of the tiny crypthanthe occurrence. Coordinates were determined during field survey using a Garmin satellite-based global positioning system navigator set for a NAD 83 map datum. According to the Garmin website, accuracy for GPS receivers is on average within 15 metres.

UTM2 Easting and Northing
For some larger sites, another set of coordinates was recorded at the end of the area of occupancy opposite from the first set of coordinates.

Topographic Position
A description of where the site for tiny cryptanthe is in the overall landform or landscape. A standard selection of categories were provided to select from on the field form including upland plain, upland depression, ridge crest, upper slope, mid slope, dip slope, bench, lower slope, toe, terrace and floodplain. Some sites included a variety of topographic positions.

Aspect
The direction a slope faces. A compass was used to determine aspect. For sites that were not level, one or more of the following eight directions were recorded – N, NE, E, SE, S, SW, W, NW.

Slope
A measure of the steepness of a slope. Percent slope was estimated by the observer. Observer estimates of slope were initially calibrated using a clinometer. A level site has 0% slope. Degree equivalents are as follows: 5%=3°, 10%=6°, 15%=9°, 20%=11°, 25%=14° and 30%=17°.

Soil Range Site and Texture
Soil texture at the surface was determined by feel as described in training manuals for Alberta government range managers (LandWise Inc. 2002). Soil that did not remain in a ball when wetted was described as sand and texture was classed as very coarse. Soil that remained in a ball but did not form a ribbon when squeezed was described as loamy sand (sandy) and texture was classed as very coarse to moderately coarse. Soil that made a weak ribbon (<1 inch long) when wetted was described as sandy loam (loamy) and texture was classed as moderately coarse to medium. No soil sampled formed a medium or strong ribbon, which would have led to a determination of loam, silty loam, clay loam, sandy clay, silty clay or clay (clayey) with fine texture.

Moisture Regime
Moisture regime is an assessment of how much moisture a site generally receives and remains available ecologically. Seven classes are recognized.

xeric – very dry, little precipitation or high evapotranspiration, low available water storage capacity
subxeric – dry, low available water storage capacity
mesic – moist, intermediate to high available water storage capacity
subhygric – moist to wet, variable available water storage capacity, seasonal seepage
hygric – wet, variable available water storage capacity, permanent seepage
subhydric – wet, variable available water storage capacity, excess water most of time
hydric – very wet, standing water constantly

Soil Drainage
Soil drainage is an assessment of soil permeability, level of groundwater and seepage. Four classes are recognized.

Rapid to well drained – Soil moisture content does not normally exceed field capacity.
Moderately well drained – Soil moisture in excess of field capacity remains for a small, but significant period of the year.
Somewhat poorly drained – The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year.
Poorly drained – The soil moisture in excess of field capacity remains in all horizons for a large part of the year.

Plant Community
Plant community is the community type that is predominant in the search area in which the tiny cryptanthe sites are found. Community type was determined using the key to the community-types (CT) in the CFB Suffield National Wildlife Area found in Appendix 7 of the CWS report *Vegetation Component Report: Canadian Forces Base Suffield National Wildlife Area* (Adams et al. 1997).

% Woody Cover
An estimate of canopy cover of tree and shrub species (e.g. *Artemisia cana, Rosa woodsii*) expressed as a percent of the area of occupancy of tiny cryptanthe.

% Bare Ground
An estimate of the amount of ground that does not have rooted plants or plant litter expressed as a percent of the area of occupancy of tiny cryptanthe.

Associated Plant Species
Vascular plant species, other than the dominant species identified in the plant community name, which are found on sites where tiny cryptanthe occurs. Species are identified by the first four letters of the genus name and the first three letters of the species epithet.(e.g. Sals kal represents *Salsola kali*). Nomenclature is according to Moss and Packer (1983).

Notes
These are general observations on association of tiny cryptanthe with natural and human disturbances, or not.

APPENDIX 2 - Metadata and file names

Data used in the creation of the CFB Suffield Tiny Cryptanthe Report Map are stored in a folder named Tiny Cryptanthe Inventory archived at the Environmental Stewardship Branch, Canadian Wildlife Service, Prairie and Northern Region, Edmonton, Alberta. This folder contains the following data files:

TC_Suffield _Historic_Data.shp - Historic site records obtained from literature cited in this report (See Table 1).

2004_Tiny_Cryptanthe_Sites.shp – 2004 data provided by Dean Nernberg in an Excel file spreadsheet.

2005_TC_Survey_CFB_Suffield.shp - Data from 2005 survey conducted by Cheryl Bradley data and transmitted in Excel file spreadsheet.

2004_2005_TC_Sites.shp – Georeferenced sites for both years.

Tiny_cryptanthe_search_areas_2004.shp – Digitized by Canadian Wildlife Service, Edmonton, off a paper map provided by Dean Nernberg.